Of the Annamese we learn that the king usually rode on an elephant when he appeared in public; sometimes he was borne in a sort of hammock by four men. At court ceremonies his throne was surrounded by thirty female attendants, armed with sword and buckler. A curious custom in warfare was to bind five men together in one file; if one tried to run away the whole file was condemned to death.

The implicit faith in the virtue of written charms is illustrated by the proceedings to be taken when one of the people was killed by a tiger or a crocodile. In this case the high priest was ordered to write out a number of charms and scatter them about at the spot where the person was killed. Such was believed to be the power of the charm that the guilty animal would be invariably attracted to the place, but before he could be done away with, a royal order had to be secured.[5]

The jewel treasures of Ceylon always excited the wonder and admiration of the early travelers to that island, and Chau Ju-Kua is no exception to this rule. His description of the king's personal appearance is scarcely flattering. He is black, with unkempt hair and bare head, his body only covered with a cotton cloth of various colors wound about him, but of his abode we read:[6]

"His palace is ornamented with cat's-eyes, blue and red precious stones, carnelians and other jewels; the very floor he walks upon is so ornamented. There is an eastern and western palace, and at each there is a golden tree, the trunk and branches all of gold, the flowers, fruit and leaves of cat's-eyes, blue and red precious stones, and such like jewels. At the foot of these trees are golden thrones with opaque glass screens. When the king holds his court he uses the eastern palace in the forenoon and the western in the afternoon. When (the king) is seated, the jewels flashing in the sunshine, the glass (screens) and the jewel-trees shining on each other, make it like the glory of the rising sun.

"The king holds in his hand a jewel five inches in diameter, which can not be burnt by fire, and which shines (in the darkness of) night like a torch. The king rubs his face with it daily, and though he were passed ninety he would retain his youthful looks."

The throne of the king of Cambodia was made of "the seven precious substances," with a jeweled dais and an ivory screen. He was said to have 200,000 war elephants—a glaring exaggeration—and four large bronze elephants, each weighing 4,000 catties, stood as guards about a bronze tower or temple in the capital.

A strange test of true royalty is noted in Palembang, eastern Sumatra. Here the royal cap was of gold, studded with hundreds of precious stones, and of such crushing weight that few were able to wear it. On a king's demise all his sons were summoned together and the one who proved strong enough to bear the weight of this cap was proclaimed as the new sovereign.

The few details we have cited from this work will give some idea of the interest and value of the volume, and the full and scholarly notes with which it has been so liberally provided by its translators and editors add much to its worth as a book of reference.

GEORGE F. KUNZ

[5] *Op. cit.*, pp. 47, 48.

[6] *Op. cit.*, pp. 72, 73.

SPECIAL ARTICLES

FURTHER EXPERIMENTS ON OVARIAN TRANSPLANTATION IN GUINEA-PIGS

FOR several years we have been engaged in studying the effects of ovarian transplantation upon the inherited color characters of young guinea-pigs developing from eggs liberated by a transplanted ovary. Our method has been to transplant the ovary taken from an animal of one color variety into the body of an animal of a different color variety and then to observe whether the young showed the color characters of the mother which bore the young or of the animal which furnished the ovary, or of both. In 1909[1] we reported the first crucial experiment bearing on this ques-

[1] "A Successful Ovarian Transplantation in the Guinea-pig and its Bearing on Problems of Genetics," SCIENCE, N. S., Vol. 30, pp. 312–314. 1909.

tion, which was more fully described with illustrations in 1911.[2] In a postscript to our 1911 publication we described a second crucial case, and it is the purpose of this note to record a third.

In the first case, the ovaries of a black guinea-pig were transplanted into the body of a white one, where they developed and liberated ova for a period of more than one year, in the course of which six young were produced, all black-coated like the animal which furnished the ovary, but not like the animal which bore the young. The foster mother differed from the animal which furnished the graft, to the best of our knowledge, by only a single genetic color factor. The ovarian tissue taken from the black animal evidently possessed this factor (the so-called "color-factor") and retained it throughout its sojourn in the body of the albino, for it was transmitted in the eggs liberated within the body of the albino, a thing which never occurs in normal albinos.

In the second case, as in the first, the same color-factor difference existed between the animal which furnished the graft and the one which received it, the latter being an albino, the former colored, while as regards other color-factors graft and grafted were alike. But in Case 1, as already stated, the colored animal was black and the albino was a *potential* black, lacking color; whereas in Case 2 the colored animal was brown-eyed cream and the albino was a *potential* brown-eyed cream, lacking color. In the pair of animals used in Case 1 two color-factors occurred which were lacking (or different) in Case 2. In Case 1 *black* and *extension* of color were present in graft and grafted animal alike; in Case 2 these were replaced by *brown* and *restriction* respectively. Nevertheless the same negative result was observed in both cases as regards the effects of grafting. In Case 2, the grafted albino foster mother bore a brown-eyed cream young one by an albino mate. She also bore two albino young, but this is not to be regarded as evidence of somatic influence of the foster mother, for it is known that animals of the stock of guinea-pigs which furnished the graft were heterozygous in albinism, so that the ovarian tissue would be expected to furnish equal numbers of ova transmitting the brown-eyed cream character and albinism, respectively. As we said in 1911, "The character of the young obtained and their numerical proportions are exactly such as the colored animal herself would have been expected to give had she not been sacrificed to furnish the grafts but had been mated with the albino male."

The third (and new) case involves a wholly different factor, the *agouti* hair pattern, both animals being colored and alike, so far as known, in all genetic factors except the agouti. For both were *brown* pigmented (not black), with *extended* (not restricted) pigmentation, and in the families of both albinism occurred as a recessive character. The grafted animal in this case was a brown (or "chocolate") animal, No. 2,562. Her parents were of the same color. At about six weeks of age, on June 9, 1910, she was castrated and then received the ovaries from female No. 2,564, a light cinnamon guinea-pig about one month old, and of the same color variety as her parents. On either side of the body an ovary was stitched to the "horn" of the uterus about a centimeter from the normal position of the ovary. After recovery the grafted animal was placed in a pen with male 2,420, an albino whose parents were brown-eyed cream. From a mating with this animal the expectation would be that a brown mother would produce brown young (or albinos potentially brown), while a cinnamon mother would produce cinnamon young (or albinos potentially cinnamon).

The grafted mother produced five young as follows: In November, 1910, a male albino; on June 25, 1911 (more than a year after the operation), a female light cinnamon, No. 2,986; on September 1, 1911, a male light cinnamon-and-yellow, No. 3,016; on November 10, 1911, a male albino; on January 29, 1912, a female albino.

[2] "On Germinal Transplantation in Vertebrates," Carnegie Institution of Washington, Publ. No. 144, 26 pp., 2 pl. 1911.

On July 15, 1912, over two years after the operation, the grafted mother was noted as still having well-developed mammæ and genitalia, as if she possessed functional ovarian tissue. On November 25, 1912, she died and there was found *post mortem* a large cyst in the uterus on the right side, and on the left side at the site of the graft a large ovarian mass, doubtless the source of the functional ova liberated during the two years previous. No microscopic study of this tissue was made, as it was already in an advanced stage of decomposition when observed.

To summarize the record, two of the five young were colored, and three were albinos. Both of the colored young were cinnamon, like the graft producer, rather than brown like the foster mother. As regards the albinos, it remained to ascertain whether they were *potential cinnamons* or *potential browns.* This required a breeding test which we were able to complete in the case of one of the three only. This animal, a male, when mated with brown females, produced two brown and one cinnamon young, showing that he was potentially a cinnamon though heterozygous for brown. He had accordingly inherited cinnamon from his foster mother, or rather from the graft which she contained, for his albino father did not transmit cinnamon. This could be inferred from the fact that the brown-eyed cream ancestors of the albino father were known not to transmit cinnamon, but it was further established by mating him with brown females, by which he produced five brown young and two albinos but no cinnamons.

If, as stated, the albino father, No. 2,420, did not transmit cinnamon, then his cinnamon offspring, or *potential cinnamon* albino offspring, by the grafted brown mother, would have to be merely *heterozygous* in cinnamon. Therefore, we should expect only half of *their* young to be cinnamon, when they were mated with brown animals. The potential cinnamon albino, as already noted, when so mated, had one cinnamon and two brown young.

Finally, the cinnamon female, No. 2,986 borne by the grafted mother, was mated with her albino father (*potentially* a brown-eyed cream, since his parents were of that recessive variety). She produced eight young, of which five were brown-eyed creams, two albinos and one a cinnamon; expectation 2:4:1. The production of a cinnamon young one in this mating shows that the cinnamon animal not only inherited but also transmitted the cinnamon character, as if her mother had been a cinnamon animal instead of a cinnamon graft in a brown animal. The sojourn and development, in the body of a brown animal, of an ovary taken from a cinnamon animal does not seem to have altered in any respect the initial genetic potentialities of the germinal substance.

These three cases form a substantial body of evidence in favor of the view originally advanced by Weismann that in the higher animals germinal substance and body are physiologically distinct, and that the genetic potentialities of the latter are not subject to modification through somatic influence.

It may be of interest to note that in our entire work 141 female guinea-pigs were grafted with foreign ovaries. Of these about 100 were mated with males long enough to give definite indications of their ability to produce young. Only 3, as noted, actually produced young, but in 7 others engrafted ovarian tissue persisted for many months and was demonstrated *post mortem.* In 11 cases ovarian tissue was regenerated at the original ovarian site and in 3 of these cases young were produced having the genetic characters of the mother, but never those of the graft. In 87 cases no ovarian tissue whatever was found *post mortem,* the castration having been completely successful but the transplanted ovaries having failed to persist for any length of time in the foreign body.

The small percentage of successful transplantations indicates that the method is not likely to be useful practically in the domestic animals or man unless some means can be discovered for increasing the tolerance of the body to foreign tissues. We have considered in this connection the possibility of increasing this tolerance by holding the tissue to be

transplanted for a time in an artificial nutrient medium or even in serum from the animal to be grafted, allowing thus a preliminary adjustment to the new environment, but have had no opportunity to give such methods a trial. They are mentioned as possible suggestions for some one who may be able to attack the problem fully equipped with a knowledge of the principles governing immunity and anaphylaxis.

This investigation has been carried out in the Bussey Institution with assistance from the Carnegie Institution of Washington.

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Nutrition and Sex Determination in Rotifers

In an interesting paper in the August, 1913, number of the *Journal of Experimental Zoology,* Claude W. Mitchell communicates a series of observations and experiments upon the rotifer *Asplanchna,* from which he draws conclusions at variance with those hitherto advanced by investigators who have worked with *Hydatina.* His main conclusion, it appears to me, is that "qualitative and quantitative changes in nutrition will be found the universal sex-controlling factor in this group" (rotifers). If it be granted that other factors than nutrition also play the same role in sex determination in one rotifer as in another, I think it may be shown that Mitchell's experiments are not calculated to prove his contentions.

There is, in the first place, some obscurity in the use of the word "nutrition." By the earlier workers on life cycles in rotifers and daphnians, nutrition was measured by the quantity of available food. The rate of reproduction gave a key to the degree of nutrition, but the rate of reproduction was supposed to be proportional to the amount of available food. It is obvious, however, that nutrition may be measured by the quantity of food that an organism can *assimilate,* which may be independent of the amount *available.* In rotifers, for example, there are periods in which reproduction and growth are rapid, alternating with periods in which these processes are slow. Mitchell does the service to emphasize this "physiological rhythm." Rotifers in the period of rapid growth will live well under external food conditions that would reduce rotifers in a period of depression almost to starvation.

When we say that nutrition determines sex, what meaning do we put upon nutrition? One might assume that Mitchell regards nutrition and physiological "level," to use another term of his, as synonymous, were it not that in the seventh paragraph of his summary he lists them separately. To quote:

> Maximum male production is determined by three factors, physiological rhythm, high nutrition and starvation during the growth period.

If nutrition means the quantity of food available, the evidence in its favor as a sex determinant is so small as to be negligible. The experiments of Mitchell do not prove its effectiveness in *Asplanchna,* as I hope to show below, and my own work on *Hydatina* is not only distinctly against it, but explains away the positive results of Nussbaum. If nutrition means the quantity of food that can be assimilated, then high nutrition is probably the result of an antecedent physiological change that is not nutrition at all. Rhythms of reproduction and growth occur in *Hydatina,* in protozoa, in *Cladocera,* and perhaps many other animals; but so far as I know, the physiological change preceding a wave of rapid growth has not been discovered. It may be a chromosomal change. If the wave of rapid reproduction is accompanied by a wave of many male producers, it seems to me we are much more justifiable in assuming that both high nutrition and male production are here the result of some other physiological factor, than in holding the male production to be a result of the nutrition. That the evidence of high nutrition comes earlier in a series of generations than does the evidence of male production may be due to the fact, true at least for *Hydatina,* that sex is determined a generation in advance without any visible sign of such determination. I revert to this point,